Title of the Invention

QUICK CHANGE POWDER COATING SPRAY SYSTEM

Related Applications

This application claims the benefit of United States Provisional patent application serial nos. 60/277,149 filed on March 19, 2001, and 60/238,277 filed on October 5, 2000, the entire disclosures of which are fully incorporated herein by reference.

Field of the Invention

The invention relates generally to powder coating spray systems which use powder containment spray booths and power overspray recovery apparatus. More particularly, the invention relates to a powder coating spray system that exhibits fast cleanability and quick color change capability by minimizing powder overspray residence within the recovery system or within various stages of the recovery system.

Background of the Invention

Powder coatings are commonly applied to objects by powder spray guns that may be manually operated or automatic. In an automatic system, one or more spray guns are controlled to spray powder onto the objects as the objects are conveyed past the guns. In a manual gun operation, typically the object is suspended or otherwise positioned near a spray gun and the operator controls when the gun starts and stops spraying. A powder spray gun may be selected from a wide variety of gun designs. Since a spraying operation is intended to coat an object evenly, a common technique for spraying powder is to apply an electrostatic charge to the powder particles which causes the powder to better adhere to the object and also results in a more uniform application. Electrostatic spray guns include corona guns and tribocharging guns. In a corona type spray gun, a high voltage electrode is positioned in or near the powder flow path, either within the gun itself or just outside the gun near or at the gun nozzle. In a tribocharging type gun, the powder flow path through the gun body is made of suitable materials that impart an electrostatic charge to the powder as it is forced through the gun body.

The object being sprayed is electrically grounded such that the charged powder is attracted to and adheres to the object. This electrostatic attraction increases the transfer efficiency by increasing the amount of powder that adheres to the object. Transfer efficiency refers to the relationship between the amount of powder that

adheres to the object being sprayed versus the amount of powder sprayed from the gun.

In most electrostatic spray systems, the powder is ejected from the gun nozzle as a cloud. This permits the powder spray to envelope the object to coat all the surfaces of the object, even when the object is irregular in geometric shape. Multiple guns may be positioned on different sides of the object and/or directed at different angles to increase the uniformity of the powder applied thereto. However, due to the inherent nature of the powder spray pattern, there is a substantial amount of powder that does not adhere to the object and ends up either falling to the floor or collecting on other objects and structures in the immediate area. This non-adherent powder residue is generally referred to as powder overspray.

Known powder spray systems utilize a source of powder that feeds powder to the spray guns. The supply system is commonly referred to as a powder feed center and may include a number of powder pumps that transfer powder from a feed hopper through a series of power hoses to the spray guns inside the spray booth. In general, an "application system" includes, as the powder flow path, at least spray gun, a powder source such as a feed hopper, a powder pump and a powder feed hose that connects the pump to the gun. In a known feed center, a suction tube or lance extends down into the feed hopper at one end and is connected to a powder pump at an opposite end. The pump draws powder from the hopper and the powder then flows from the pump through the powder feed hose to the spray gun. In such known systems, the powder flow path typically includes one or more turns, of about ninety degrees or so for example, and these non-straight paths can inhibit thorough cleaning during a color change operation. The known feed centers also require substantial time to purge and clean as part of a color change operation.

The presence of powder overspray necessarily dictates that there must be more powder passing through the spray system than is actually used to coat the target object. In other words, a substantial amount of powder is cycled through a spray system in the form powder that collects in the booth and in various filter and collection systems, and this amount of powder is far greater than the actual amount of powder that adheres to a target object. This excess powder is subject to contamination and in general adds to the problem of purging and cleaning the spray system in preparation for a color changeover.

Because powder overspray is generated during each spraying operation, spraying operations typically are performed within a spray booth. The spray booth is used for powder containment and may only be partially enclosed. Most spray booths have an air flow system that contains the powder overspray within the structure of the booth by producing a negative pressure zone that draws air from the powder booth along with powder overspray that is entrained in the air flow. The powder laden air is then transferred to a cartridge filter system or cyclone separator system outside the spray booth to recover the powder. However, in known spray booth systems, the powder overspray still tends to collect on the booth walls, ceiling and the booth floor. In electrostatic systems especially, the powder overspray will also tend to be attracted to and collect on any structure that is electrically grounded. The powder particles tend to be very small and well dispersed and therefore can collect in the smallest of recesses, seams and crevices and irregular spray booth wall structures.

Powder overspray presents a two-fold challenge. First, if possible it is usually desirable to try to reclaim or recover powder overspray so that the powder can be re-used during subsequent spraying operations. Known powder recovery systems typically work on the basis of a large air volume that entrains the powder overspray. These air flow volumes are routinely generated by conventional high volume exhaust fans. The powder laden air is then filtered, such as for example using cartridge type air filters or cyclone separators. The separated powder is then sieved to remove impurities and returned to a hopper or powder feed center where it is supplied once again to the spray guns. In known systems, the actual reintroduction of recovered powder to the powder spray application system is usually accomplished by a positive air pressure conveyance system back to a powder feed center through a series of hoses, valves and pumps. These additional components significantly increase the complexity of cleaning out the spray system for a color changeover.

Besides the challenge of recovering powder overspray for subsequent use or disposal, powder overspray that collects within the spray booth must be removed from the booth when changing over the powder coating color. In order to switch from one color to another the guns, booth and powder recovery system must be as completely purged of the previous colored powder as possible to prevent contamination of the subsequent colored powder. The operation of changing from one color to another is generally known as a "color change" operation and it is an ongoing challenge in the art to make spraying systems that are "quick color change" meaning that the goal is to

keep reducing the down time when the spraying system is off line in order to clean the spraying apparatus and system. Thus, the amount of in-process powder, as well as the amount of powder overspray that remains in the spray booth, have a significant impact on the amount of time and effort it takes to perform a color change operation.

In known systems, a significant problem with cleanability and color change is that the powder, once it is sprayed from the guns, is not continuously recycled back to the feed center, but rather becomes resident at various stages within the spray system. In some systems for example, powder overspray may reside within the spray booth until a separate cleaning operation is performed after spraying is completed. Even in systems in which overspray is collected during a spraying operation, substantial amounts of powder can remain in the spray booth. Furthermore in some systems, powder overspray that is removed from the spray booth goes to a cyclone separator and falls into and resides in a cyclone bin until it is transferred to the feed center. The cyclone bin can be time consuming to clean. The transferred powder may then pass through a mini-cyclone in the feed center (because the powder from the cyclone is transferred under positive air pressure to the feed center and therefore is entrained in an air flow) before being dumped back into the feed hopper. Again, in this stage the powder may still reside in the mini-cyclone or sieve for a time before being returned to the feed hopper. If a cartridge filter system is used instead of a cyclone separator, the powder resides in the filters themselves until pulse cleaning is applied, and in any case the cartridge filters must be completely replaced during a color changeover.

A problem with the powder overspray residing in various stages of the spray system is that the powder will tend to find even the smallest nook and cranny and even cake up, and substantial time will need to be spent cleaning this powder out.

Thus, color changeover typically includes having to clean powder from three major subsystems: the spray booth, the powder separator, and the feed center. Each subsystem has its own unique challenges to reducing the time it takes to completely clean out one powder color to prepare the system for spraying another color. During the cleaning time the spray system is completely down or off-line which represents lost time and increased costs, in addition to the costs associated with the labor needed to clean the various system components.

Cleaning a powder coating spray booth can be a labor-intensive effort. Powder coating materials, in varying degrees, tend to coat all the internal surfaces of the spray booth during a powder coating spray operation, which directly impacts color

change time. In a production powder coating environment, minimizing the system down time to change from one color of powder coating material to another is a critical element in controlling operational costs. Seams between booth panels and recessed ledges, such as where access doors or automatic or manual spray application devices may be located, are typically hard to clean areas and tend to hold concentrations of oversprayed powder coating material that could present a contamination risk after a color change. In addition to seams and ledges and other recesses within the booth, charged powder can adhere to booth interior surfaces.

In typical powder coating booth construction, an outer steel framework is provided for supporting individual panel members which form the roof, side and end walls of the booth. These panel members are known to be made of a fabricated or thermoformed plastic, such as polypropylene, polyvinyl chloride (PVC), polyvinyl carbonate or polycarbonate. The floor may also be of thermoformed plastic or stainless steel construction. In other known embodiments, powder coating spray booths can have metallic walls, ceilings and vestibule ends, as well a metallic floor and exterior support framework.

U.S. Patent No. 5,833,751 to Tucker is an example of a powder coating spray booth intended to reduce powder particle adhesion to the interior surfaces of the booth during an electrostatic powder spray operation. Tucker discloses a booth chamber comprising a pair of thermoformed plastic shells with smooth curvilinear interior surfaces that are intended to inhibit oversprayed powder particle adhesion. Two identical ends connect with the shells and an external support frame is disclosed, but not shown. Possible booth materials disclosed include polycarbonate.

Known booth materials are available in limited sizes requiring some method of seaming to generate the overall size. These seams require much effort and cost to achieve a virtually uninterrupted, seamless surface.

In addition, known powder coating spray booths have numerous features that reduce operational efficiencies. These sub-optimal features are evidenced during powder coating color changes between successive runs of different coating colors and during assembly and maintenance of the booth itself. Known powder coating spray booths use metallic external support frames and stainless steel or thermoplastic,

floors, walls and ceilings. During an electrostatic powder spray coating operation, oversprayed powder material can actually be attracted and adhere to these booth interior surfaces. Higher concentrations of oversprayed powder coating material are typically seen in the immediate vicinity of the highly conductive steel frame members, which are typically grounded. Although thermoformed plastics are typically thought of as insulators, their insulation properties vary and powder particle adhesion can vary with the conductance and resistance of these materials. With age, physical properties of the thermoformed plastic materials can change with corresponding increases in powder particle adhesion, as they can absorb moisture from the ambient air over time. Ultraviolet light is also known to change the physical properties of thermoplastics over time.

In addition, typical booths have numerous design features that act to increase accumulated oversprayed powder coating materials in the spray booth, thus increasing cleaning times during color change operations. In booths using panel members connected with each other and supported by an external frame, numerous seams exist throughout the booth interior that entrap oversprayed powder coating material, thereby making the booth harder to clean during a color change or routine booth maintenance. In addition to the seams, ledges are present in some powder coating spray booths on which spray gun application devices rest and are mounted, and where openings for doors and other access portals are reinforced and secured, for example. These ledges can either extend into the booth or, more typically, extend away from the inner surface of the booth. Even if otherwise angled or curved toward the floor from the typically vertical side walls, oversprayed powder coating material still tends to accumulate in these areas, thus making them more difficult to clean, as well.

Known prior systems for removing powder overspray from a spray booth include active systems in which floor sweepers and other mechanical devices are used to mechanically contact the powder and push it off the floor into a receiving device. These systems however tend to be cumbersome and are not thorough in the amount of powder removed from the booth. A substantial effort by one or more operators is still required to completely remove powder from the booth. Thus there can be a large amount of in-process powder and powder overspray on the booth structure.

In passive removal systems, powder is removed from the floor in a non-contact manner. In one known system, a rectangular floor in the form of a continuous linearly moving belt transports powder over to a collection device such as a vacuum system that removes powder from the belt. Such systems are very complicated mechanically and do not do an adequate job in removing powder from the belt, so much so that in some cases a color change requires a change of the belt itself.

It is desired therefore to provide a spray booth that is easy to clean as part of a color change operation and operates so as to minimize the amount of in-process powder and the amount of powder overspray remaining in the spray booth after a spraying operation is completed.

It is further desired to provide a powder coating spray system and associated subsystems including a powder recovery system that substantially reduce the residence time of powder overspray within the system between the spray gun nozzle and the feed hopper. The spray system should remove as much powder overspray as possible from the spray booth and transfer it back to the feed center during a spraying operation. Thus the amount of residual powder overspray needing to be manually cleaned from the subsystems will be largely eliminated. It is further desired to provide a powder feed center that is easier and faster to clean as part of a color change operation.

Summary of the Present Invention

The present invention is directed to a new powder coating spray system that is dramatically faster and easier to clean, thereby significantly reducing the time required for a color changeover. In accordance with one aspect of the invention, a powder coating spray system produces a region of high air flow through a spray booth to extract powder overspray from the booth. The high air flow is produced by a low pressure source outside the booth. In one embodiment, a suction duct is positioned above the booth floor and the air flow into and through the duct sucks up powder from the floor and transports it outside the booth to a collection device. Relative rotation between the floor and the duct permits the entire floor to be swept, and in one embodiment the booth is generally cylindrical and the floor is round rotates about a longitudinal axis of the booth. In another embodiment of the

invention, the spray booth walls and floor are made of non-conductive composite materials.

In accordance with another aspect of the invention, powder overspray that is extracted from a spray booth is recovered back to a powder supply that is used to supply powder to the spray guns inside the spray booth. In one embodiment, the extracted powder overspray is separated from the high flow air stream by a cyclone separator. The powder falls into a transfer pan and a vacuum is used to convey the powder from the transfer pan to a vacuum receiver. The powder is then discharged to the feed hopper in the feed center. The use of a vacuum to convey powder from the cyclone to the feed center in effect permits substantially all of the powder overspray to be recovered from the spray booth directly to the feed hopper with minimal dwell or residence time within the cyclone or vacuum receiver subsystems during a spraying operation. What little powder remains from the powder recovery during spraying operations can be quickly and easily blown-off as part of a cleaning and color changeover procedure.

In accordance with another aspect of the invention, cleaning of the system is facilitated by a powder vacuum receiver in the powder feed center that can be rotated for easy powder blow-off, and that has a gravity controlled outlet door that periodically discharges recovered powder to the feed hopper. In one embodiment the receiver uses color specific filters that are easily replaced during a color changeover.

In accordance with another aspect of the invention, the powder feed center is designed to facilitate faster color change operations. In one embodiment, one or more powder pumps are used that have an in-line powder flow path that extends between the pump powder inlet from the suction tube to the pump powder outlet that is connected with the spray gun feed hose. This arrangement provides a straight through powder flow path without any ninety degree turns. In a further embodiment, a powder spray gun is used that also provides a straight through powder flow path. Thus, a powder application system is provided in which powder flows from the feed hopper to the spray gun nozzle along a smooth, continuous flow path without any sharp or severe bends in the flow path. When used in combination with a powder recovery system of the present invention, an application system is provided that is easy and fast to clean and perform a color change operation, since less in process powder is used, the overspray is substantially continuously returned to the feed center, and easy to clean/purge powder flow paths are provided.

In accordance with another aspect of the invention, a color changeover procedure is provided that substantially reduces system down time. In one embodiment, the spray booth and recovery system are cleaned during the same time period to significantly reduce color changeover time. In a specific embodiment of the spray booth, the rotatable floor can also be axially position into a sealed relationship with the booth walls. The spray guns are blown-off by air jets disposed near gun slots in the booth wall as the guns are retracted from the spray booth. The powder pumps, feed hoses and spray guns are then purged into the sealed spray booth. The sealed floor permits an operator to blow-off powder from the booth walls, ceiling and the extraction duct. Once the spray booth has been blown down, the floor is lowered and the extraction system operated to extract any remaining powder from the booth floor and seal to an after-filter system or waste.

In another embodiment, the vacuum line from the cyclone to the vacuum receiver is cleaned by drawing cleaning elements through the vacuum line into the receiver. In one version, the cleaning elements are oversize foam cylinders that wipe the vacuum line as they travel therethrough. In this embodiment, the vacuum receiver is blown off when rotated to a horizontal position and the color specific filters replaced. Other parts of the feed center are also cleaned at this time.

In another embodiment of the invention, a powder coating spray system with powder overspray recovery during a spraying operation includes a generally cylindrical spray booth with a rotatable floor that rotates under a powder extraction duct suspended just above the floor. Powder overspray on the floor is drawn up into the duct while the floor rotates thereunder. The extracted powder overspray laden air is then drawn into a cyclone separator, and a vacuum pump/receiver unit in the feed center is used to convey powder from the cyclone via a vacuum line to the vacuum receiver. The vacuum receiver accumulates the recovered powder and periodically opens and discharges the recovered powder to a feed hopper via a sieve. The receiver filter is reverse shock pulsed during the discharge cycle to knock powder off the filter. Use of the powder extraction device and rotating floor, in combination with the vacuum transfer from the cyclone to the feed center, results in very small quantities of powder overspray remaining in the spray system components, thus minimizing cleaning required for color changeover.

In accordance with another embodiment of the invention, a powder overspray recovery system uses a negative pressure high air flow to produce a suction within a

spray booth to extract powder overspray to a first collection device during a spraying operation. A vacuum receiver in a powder feed center is used to transfer the powder overspray from the first collection device to the feed hopper in the feed center. Thus the overspray powder is substantially maintained in a continuous transfer from the time it is sprayed from a spray gun until it returns to the feed hopper for re-use. The vacuum transfer significantly simplifies the powder clean process needed prior to a color changeover. The recovery system leaves a minimal amount of powder in the system components during a spraying operation so that clean-up time is substantially reduced, thus making for a very fast color changeover operation.

The present invention is also directed to improved spray booth designs that are particularly suited for electrostatic spraying operations, although the various aspects of the invention may be incorporated into spray booths that do not utilize electrostatic spraying apparatus. According to one aspect of the invention, a powder extraction system is contemplated in which powder overspray can be continuously extracted from the booth even during a spraying operation. In one embodiment of the invention, a powder spray booth includes a booth canopy wall and ceiling arrangement to contain powder during a spraying operation; and a booth floor that is rotatable relative to the booth wall during a spraying operation. The booth may be generally cylindrical in shape with a round floor. The floor can be rotated about a vertical axis that is also the longitudinal axis of the spray booth. The booth canopy and ceiling are supported on a base frame separately from the floor. By this arrangement, the floor can be rotated relative to the booth canopy. By continuously removing powder overspray in a real-time manner during a powder spraying operation, the amount of in-process powder is substantially reduced and the time and effort required to clean the booth as part of a color changeover is dramatically and significantly reduced.

In accordance with another aspect of the invention, a powder extraction mechanism is provided for removing powder overspray from the booth floor. In one embodiment, the extraction mechanism is a duct that extends across the booth floor and supported just off the floor. A negative pressure source is connected to the duct to cause a suction effect by which powder overspray is removed from the floor and transported via the extraction duct to a collection device that is disposed outside the booth. In a preferred form, the extraction mechanism is stationary with respect to the rotating floor and extends diametrically across the floor.

In accordance with another aspect of the invention, the booth floor can be translated as well as rotated. In one embodiment, the booth floor can be axially translated along the axis of rotation. The floor can be moved to a first axial position in which the floor is free to rotate during a spraying operation, and a second axial position where the floor sealingly contacts the bottom of the booth canopy or wall during a color change operation. A source of pressurized air is positioned to blow powder from the seal as part of a color change operation.

Still a further aspect of the invention concerns a mechanism for effecting the axial translation of the floor. In one embodiment the floor is moved by a floor lifter mechanism that moves the floor between the first and second axial positions. In one embodiment the lifter mechanism is a pneumatic actuator that acts on a rocker arm to raise and lower the booth floor.

In accordance with another aspect of the invention, a cyclone system is used to separate the powder overspray from the air drawn in by the extraction duct. A fan is connected to the cyclone system which in turn is connected to the extraction duct. The air flow that is pulled through the duct creates a negative air pressure flow that draws up powder that has collected on the booth floor into the extraction duct and also provides containment air flow within the booth canopy. In one embodiment, the cyclone system is provided with a by-pass valve for selecting between powder overspray reclaim and non-reclaim operating modes.

Still a further aspect of the invention relates to the use of composite materials for the spray booth and floor that are very low in conductivity to minimize powder adhering to the booth and floor, while possessing significant structural properties that enable the configuration to be mechanically sound. In one embodiment, the booth canopy is made of two composite half cylinders that are entirely self-supporting so that the canopy and ceiling can be suspended over an underlying rotatable floor. In this embodiment the floor is also made of very low conductivity composite materials with sufficient structural strength to permit a floor design whereby the floor can be rotated on a central hub.

These and other aspects and advantages of the invention will be readily appreciated by those skilled in the art from the following detailed description of exemplary embodiments of the invention with reference to the accompanying Figures.

Brief Description of the Figures

Figs. 1 and 1A are isometric schematic representations of a powder spraying system in accordance with the invention, with Fig. 1A illustrating a manual spray booth or vestibule attached to the main spray booth;

Fig. 2 is a simplified top view of the spray booth and cyclone system;

Figs. 3 and 4 illustrate in elevation a typical powder coating system layout;

Fig. 5 is a plan view of a frame that supports a spray booth of the present invention;

Figs. 6 and 7 illustrate detail of a floor lift assembly for the spray booth, with the floor in the up and down positions respectively;

Fig. 8 is a plan view of the spray booth floor;

Fig. 9 is a cross-section of the floor taken along the line 9A-9A in Fig. 8;

Fig. 10 is an embodiment of a floor hub assembly in plan;

Fig. 11 is the hub assembly of Fig. 10 in vertical cross-section along the line 11-11 in Fig. 10;

Figs. 12 and 12A is an extraction duct shown in elevation and perspective respectively;

Fig. 13 is the extraction duct of Fig. 12 shown in plan;

Fig. 14 is a cross-section of the extraction duct of Fig. 12 along the line 13-13 in Fig. 12;

Figs. 15A and 15B illustrate an alternative embodiment of an extraction duct, illustrated in exploded perspective in Fig. 15A and in perspective as assembled in Fig. 15B;

Fig. 16 is the extraction duct of Fig. 15 shown in lateral cross-section;

Fig. 16A is an alternative embodiment of the extraction duct of Figs. 15A and 16 shown in lateral cross-section;

Fig. 17 is an alternative embodiment of a canopy support arrangement;

Fig. 18 is a bottom view of a bypass plenum;

Figs. 19A and 19B illustrate in elevation the bypass plenum of Fig. 18 with a bypass valve and actuator arrangement shown in two positions corresponding to a reclaim and non-reclaim mode;

Fig. 20 illustrates an embodiment of the valve element of Fig. 19 in front elevation; and

Fig. 21 is a cross-section of the valve element of Fig. 20 taken along the line 21-21;

Fig. 22 is a simplified functional schematic of an embodiment of a powder overspray recovery system according to the invention;

Fig. 23 is an elevation of a cyclone system in accordance with the invention;

Figs. 24 and 25 are plan and elevation views respectively of a cyclone vacuum interface device in accordance with the invention;

Fig. 25A is an end view of the vacuum interface device of Figs. 24 and 25;

Fig. 26 is an exploded elevation of a vacuum receiver unit in accordance with the invention;

Fig. 27 is a side elevation of the vacuum receiver of Fig. 26 taken at a 90 degree rotation;

Fig. 28 is a side elevation of the vacuum receiver unit of Fig. 26 in an assembled condition;

Fig. 29 illustrates part of a powder feed center in elevation in accordance with the invention;

Fig. 30 is a partial front elevation of the feed center with the feed hopper removed;

Fig. 31 is one embodiment of a powder pump illustrated in longitudinal cross-section;

Fig. 32 is an enlarged view of the purge manifold arrangement of Fig. 30;

Figs. 33 and 34 are schematic illustrations of exemplary powder coating application systems using an in-line powder pump and spray gun;

Fig. 35 is a representative graph comparing spray pattern characteristics between application systems using a conventional powder pump and an in-line powder pump of the present invention; and

Fig. 36 is a schematic illustration of an application system using an alternative embodiment of the in-line pump arrangement of Fig. 33.

Detailed Description of The Invention

INTRODUCTION

By way of introduction, the present invention is directed to providing a powder recovery system that takes most of the powder overspray produced in a powder spray booth during a spraying operation and returns it on a real-time basis to

the powder feed center. In one embodiment, a powder scavenging protocol is used to recover powder overspray from the spray booth on a continuous basis and return the scavenged powder to the application system on a nearly continuous basis. The powder overspray is also preferably removed from a cyclone separator and returned to the feed center on a continuous basis. By "scavenging" is simply meant the collection and transfer of powder from the time the powder is sprayed by a gun until the powder is returned to the feed center.

As used herein, the terms "powder recovery" and "powder collection" are used interchangeably. By effectively and continuously recovering most of the powder overspray, cleanup is greatly simplified thereby substantially reducing color changeover time as compared to prior systems. One embodiment of the recovery system in general includes a powder extraction system associated with the spray booth, a first powder collection/separation system, and a vacuum conveyance system in the feed center. Vacuum "convey" and "transfer" are also used interchangeably herein. It is important to note that although a complete recovery system is provided, various subsystem features may be used singly or in combination with other features disclosed herein. For example, the vacuum transfer system may be used with any powder spray booth powder extraction system, and also is not necessarily dependent on the design of the first collection/separation system. Exemplary embodiments including exemplary alternative embodiments are described here, however, such descriptions are not intended to be and should not be construed to be an exhaustive list. Those skilled in the art will readily understand that many alternatives are available for the specific embodiments described herein.

In addition to powder recovery during a spraying operation, the powder recovery system reduces the amount of residue powder in the spray system to such an extent that color changeover time is substantially reduced. Thus, the present invention also contemplates a color change procedure that is enhanced by various aspects of the recovery system itself. The color changeover procedure however may also be realized with alternative embodiments of the powder recovery system and is therefore not limited to being implemented by the exemplary embodiments of the recovery system described herein.

For ease of explanation, the various subsystems will be described herein, followed by a detailed description of the color changeover procedure.